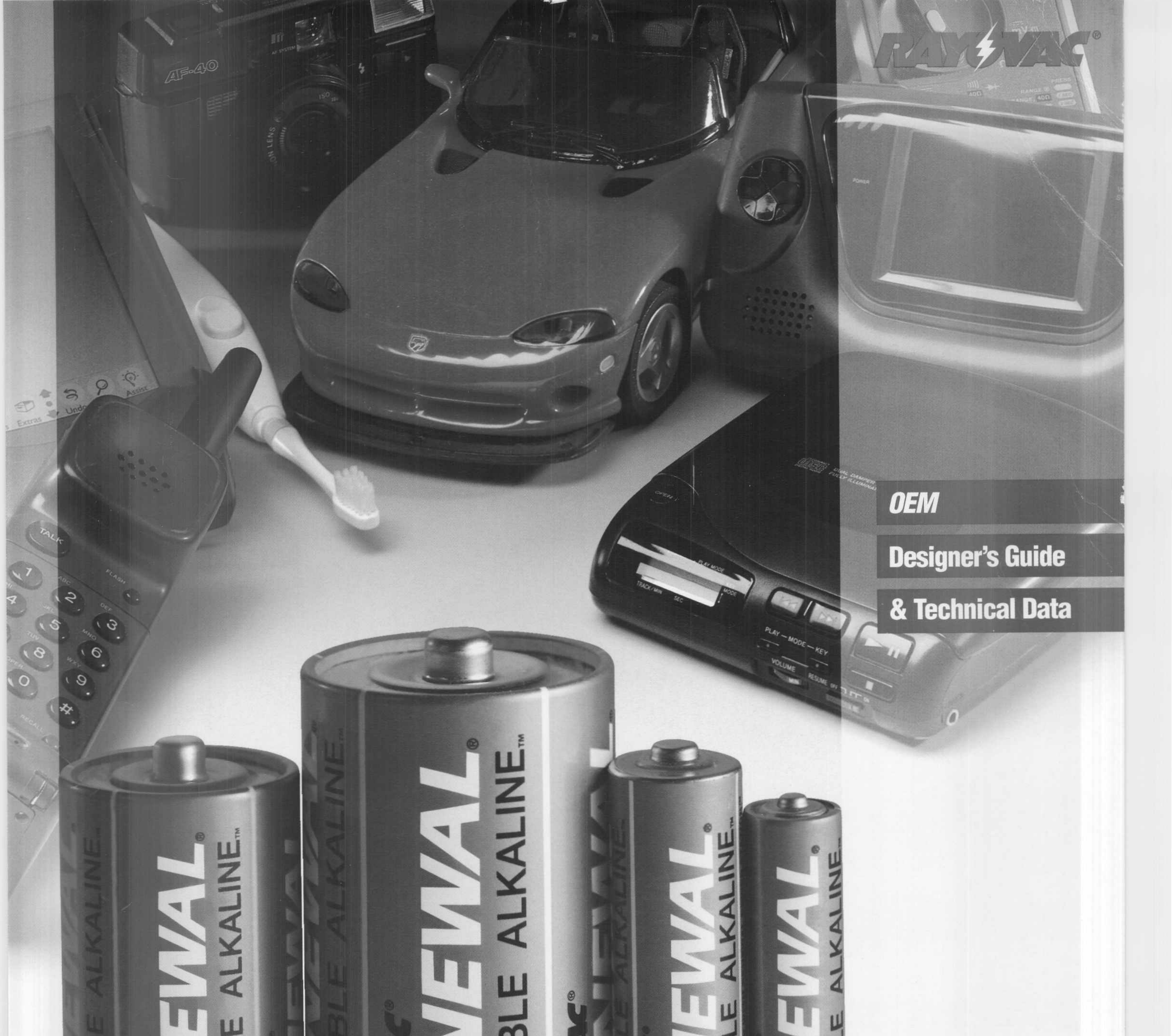


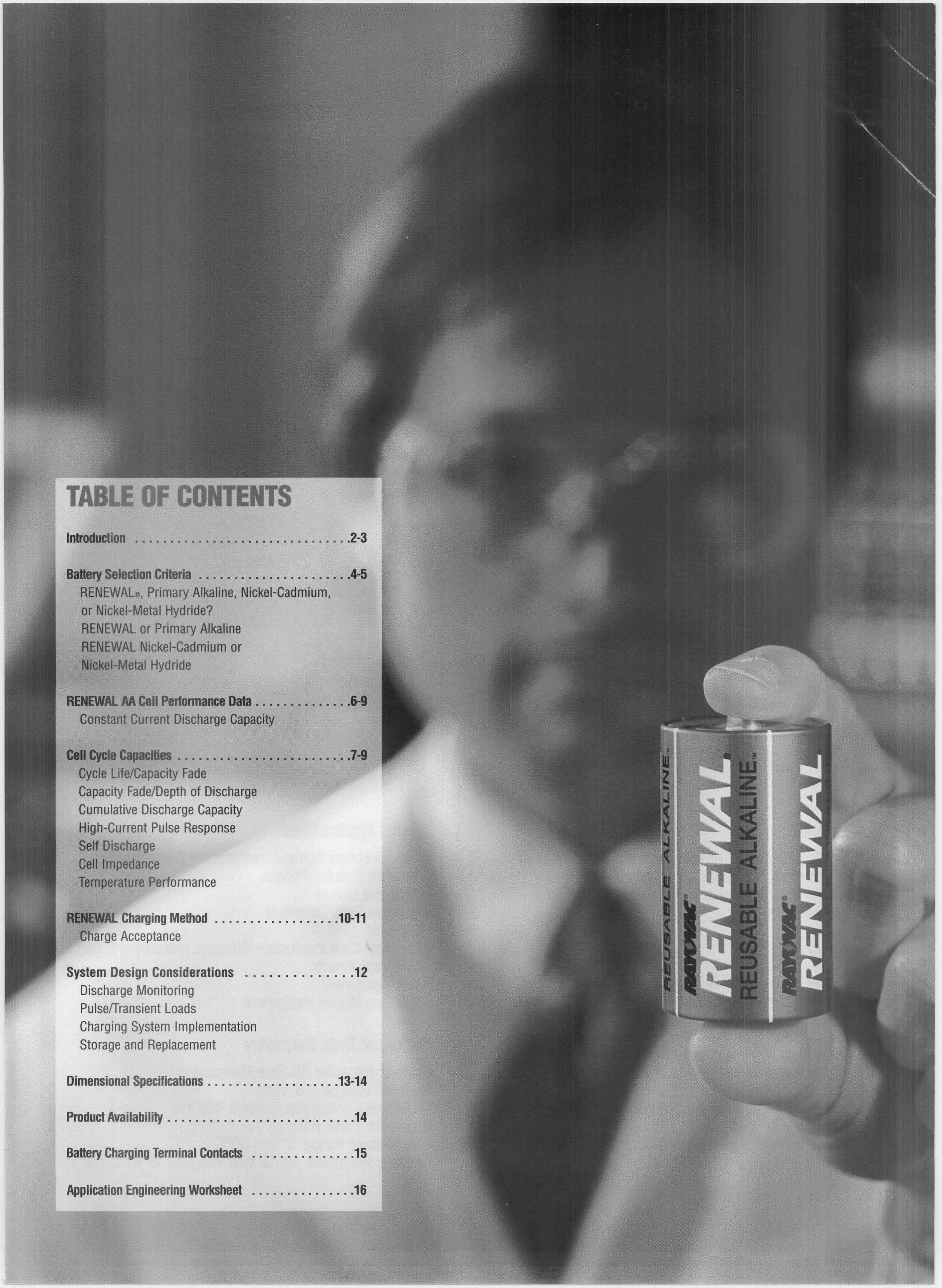
OEM

Designer's Guide

& Technical Data

The New Power

RENEWAL® Reusable Alkaline™ Batteries



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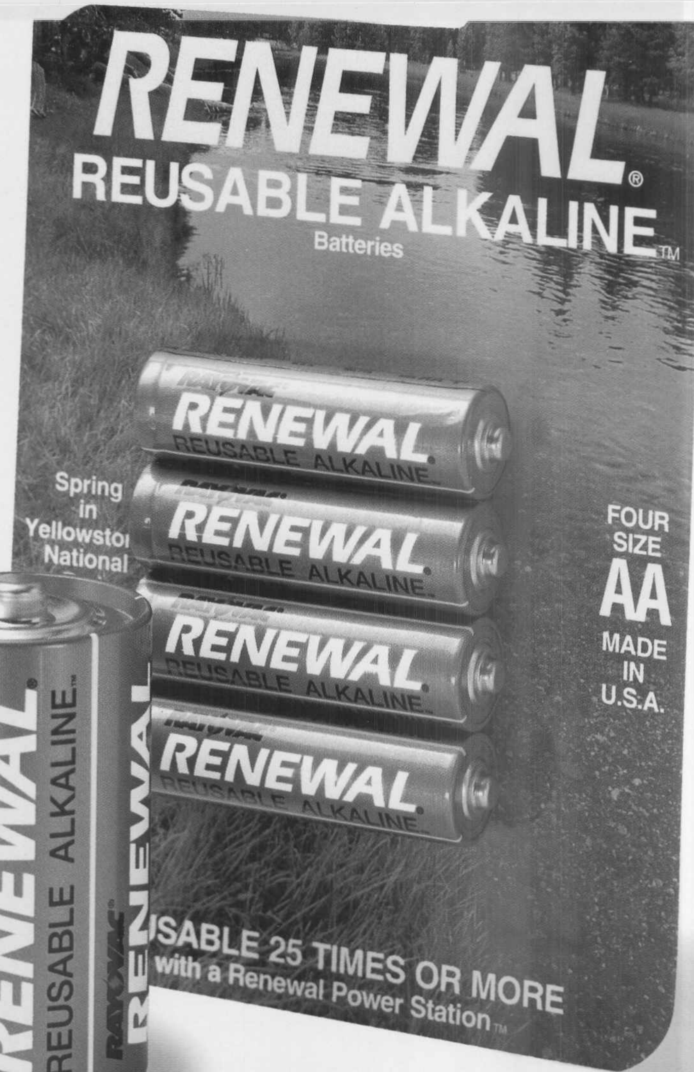
The High Performance Alkaline Battery in a Reusable System




Description

Rayovac's patented RENEWAL batteries offer the high performance attributes of regular alkaline batteries along with the cost and environmental benefits of a reusable system.

Features

- Long life to maximize device playtime
- Reusable 25 times or more
- Precharged and ready to use
- Enhances device portability
- Lasts up to three times longer per charge than NiCd
- Holds a charge up to five years in storage
- No memory problems
- Sloping discharge profile provides an early warning of low voltage
- Meets worldwide environmental legislation
- Available in standard AAA, AA, C, and D cell sizes

Typical Applications

- Sub-notebook Computers/Personal Digital Assistants
- Portable Cellular Phones
- Toys and Games
- Portable Data Terminals
- Cameras
- Personal Care Products—Shavers, hairclippers, dental care instruments
- Test Equipment
- Sporting Goods equipment

Technical Data Summary

System: Reusable Alkaline-Manganese
Nominal Voltage: 1.5 Volts
Maximum Continuous Current: 400 mA
Maximum Pulse Current: 1.5 A
Temperature Range: 0°C to 50°C
Capacity Retention: >95% after one year @ 21°C (70°F)

INTRODUCTION

The RENEWAL® Reusable Alkaline™ Battery System represents a new alternative for the designer of portable battery-operated equipment. Prior to the introduction of the RENEWAL Product family, most portable equipment was constrained to use either single-use disposable alkaline batteries or rechargeable battery systems such as Nickel-Cadmium (NiCd) or Nickel-Metal Hydride (NiMH). RENEWAL can be thought of as "bridging the gap" between the single-use primary alkaline and the traditional choices in rechargeable battery systems. It combines many of the benefits of both conventional alkaline and rechargeable Nickel-based systems.

RENEWAL can provide an excellent solution for many battery-operated products when one considers all of the various design tradeoffs such as cost, battery run-time, storage characteristics and environmental impact. However, the electronic system designer should understand that the RENEWAL battery may not be the best choice for all applications…unfortunately, *there is no single type of battery that can be considered as the best option for all classes of battery-operated electronic equipment.*

This Designer's Guide will discuss the types of applications that are appropriate for the RENEWAL battery, provide performance data for the AA cell size (which is the most popular standard size for portable products), and offer some guidelines for achieving optimal performance from the RENEWAL system. Rechargeable Alkaline Manganese batteries have existed in the laboratory for many years.

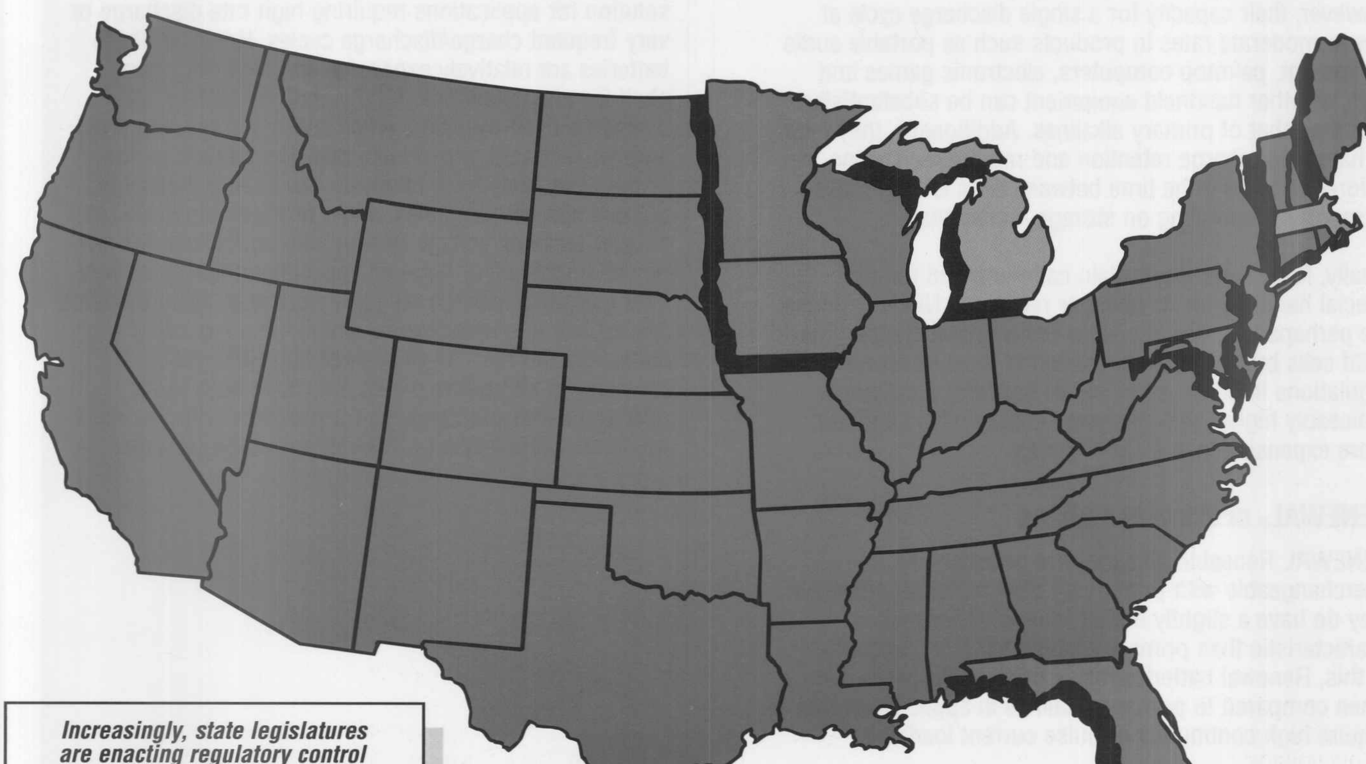
Rayovac RENEWAL offers a significant and proven solution to the shortcomings of previous efforts in rechargeable alkaline battery technology.

Rayovac has optimized the features to provide a reliable, consumer safe battery system.

The design of the RENEWAL system has the benefits of high capacity and excellent shelf life in an environmentally responsible formulation.

States with Legislation Mandating Collection of Nickel-Cadmium Batteries

States Pending Legislation Mandating Collection of Nickel-Cadmium Batteries



Increasingly, state legislatures are enacting regulatory control on other rechargeable batteries. Nickel cadmium battery users in all states will be expected to participate in a national NiCd collection program.

BATTERY SELECTION CRITERIA

RENEWAL®, Primary Alkaline, Nickel-Cadmium, or Nickel-Metal Hydride?

RENEWAL Reusable Alkaline batteries combine some of the characteristics of conventional alkaline and rechargeable Nickel-based battery products. They have a higher initial capacity than NiCd/NiMH cells, but not as high as primary alkaline. Unlike primary alkaline, they can be recharged and reused, but not for as many cycles as NiCd/NiMH.

Primary alkaline batteries are designed for a single discharge only. They have very good energy density when operated at moderate to low discharge rates (typically less than a few hundred milliamperes to one ampere drain rates) and have excellent charge retention during storage. Attempting to recharge these batteries may result in internal short-circuits between the anode and cathode, internal gas generation and probable leakage. Both primary and reusable alkaline batteries can be safely disposed of in landfills with no toxic material concerns.

NiCd and NiMH batteries can be recharged and reused many times. They have a very low internal resistance, allowing them to be used for high drain rate discharges up to several amps. They are generally the battery system of choice for relatively high-power portable devices such as power tools, notebook computers, etc. However, their capacity for a single discharge cycle at low to moderate rates in products such as portable audio equipment, palmtop computers, electronic games and toys, or other handheld equipment can be substantially less than that of primary alkalines. Additionally, they tend to have poor charge retention and require recharging before each use if the time between uses is long (days or months, depending on storage conditions).

Finally, NiCd batteries contain cadmium and require special handling for disposal or recycling. NiMH batteries are perhaps less objectionable environmentally than the NiCd cells but may still be subject to local environmental regulations in some areas. NiMH batteries also have a noticeably higher self-discharge characteristic and are more expensive than NiCd batteries.

RENEWAL® or Primary Alkaline

RENEWAL Reusable Alkalines are generally interchangeable with primary alkaline batteries. However, they do have a slightly higher internal resistance characteristic than primary alkaline batteries. Because of this, Renewal batteries may exhibit lower performance when compared to primary alkalines in applications that require high continuous or pulse current loads.

At low and moderate drain rates, where the effect of the internal resistance in the RENEWAL battery is less significant, the performance of RENEWAL can be close to that of primary alkalines. The general operation, discharge curve shape, and storage (charge retention) characteristics of RENEWAL and primary alkaline batteries are very similar.

The advantage of RENEWAL batteries over primary alkalines is the reusability of the RENEWAL system. RENEWAL batteries can be recharged because they have different internal construction and chemical composition than conventional alkalines. While the performance of a RENEWAL cell on a single discharge cycle may be less than that of a primary alkaline, the rechargeability of the RENEWAL system allows a single cell to provide a cumulative capacity equivalent to dozens of single-use cells.

Over a period of several charge/discharge cycles RENEWAL batteries can represent a significant cost savings to the end user over single-use disposable alkaline batteries. RENEWAL also presents a more environmentally responsible alternative to the large number of primary alkaline batteries that would require disposal over time when used throughout the lifetime of a given electronic product.

RENEWAL®, NiCd or NiMH

NiCd and NiMH batteries generally provide a good solution for applications requiring high rate discharge or very frequent charge/discharge cycles. However, these batteries are relatively expensive and have very poor shelf life characteristics. A fully charged battery will discharge itself over time when left in storage, requiring another recharge prior to use after the storage period. Additionally, they have relatively low energy density in comparison with alkalines at low or moderate drain rates, a lower terminal voltage (which may be relevant for low-power single-cell or two-cell applications that have very little margin or voltage range to work with. NiCd batteries are subject to environmental restrictions regarding collection and recycling at end of life. RENEWAL provides an alternative which may have both lower cost and better performance for products with low or moderate drain levels or intermittent usage patterns.

Comparison of RENEWAL® with Nickel-Cadmium and Nickel-Metal Hydride

Example: AA Cell (approximate values)

	RENEWAL®	Nickel-Cadmium	Nickel-Metal Hydride
Nominal Capacity, mAh (varies with load)	1400 (initial)	750	1100
Usable Cycles (varies with discharge level)	25+	200+	300+
Nominal voltage range (under load)	0.9 to 1.4	1.0 to 1.3	1.0 to 1.3
Weight	22g	22g	26g
Gravimetric Energy Density (watt-hr/kg)	80 (initial)	41	51
Volumetric Energy Density (watt-hr/liter)	220 (initial)	115	170
Continuous Output Current (maximum recommended)	400 mA	>5A	>4A
Peak Output Current	1.5A	>10A	>10A
Fast Charge Time (after discharge to 0.9V @ 300 mA)	2-3 Hrs	1 Hr	1 Hr
Self-discharge Rate (room temperature)	0.01% per day	1% per day	4% per day
Typical OEM Cost Per Cell	$0.50	$1.25	$3.00
Typical Retail Replacement Cost (4-cell pack)	$5.00	$10.00-$30.00	$60.00+
Safely Disposable	Yes	No	???

Note that battery performance will vary with load and environmental conditions. The comparison chart represents typical values at nominal load and temperature conditions (approximately 150 mA load at room temperature) and is a guideline of what can be reasonably expected under these conditions. It is not a definitive product specification because of the variability in characterizing different battery systems under different operating conditions.

Advantages of RENEWAL®

- Battery operated equipment can run longer between recharges due to higher capacity of the RENEWAL batteries
- RENEWAL batteries come in standard sizes and can be used in multiple devices (unlike custom-designed battery packs which are unique to a specific product)
- RENEWAL reduces the need for the user to manage battery usage patterns...it does not require full discharge before recharge, has no memory effect, and negligible self-discharge.
- Easily and inexpensively replaced by consumers when new batteries are needed
- Environmentally responsible
- Substantially better shelf life (5+ years in storage)
- Lower initial cost of cells results in lower product cost
- Low-battery warning circuitry can be simpler due to shape of alkaline cell discharge curve

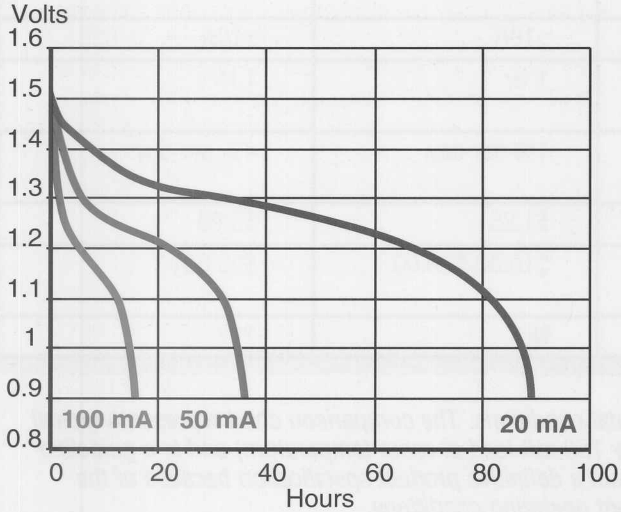
RENEWAL®
AA CELL PERFORMANCE DATA

The graphs in this data sheet enable system designers to estimate the run time, cycle life, and approximate recharge times for RENEWAL AA cells in their application.

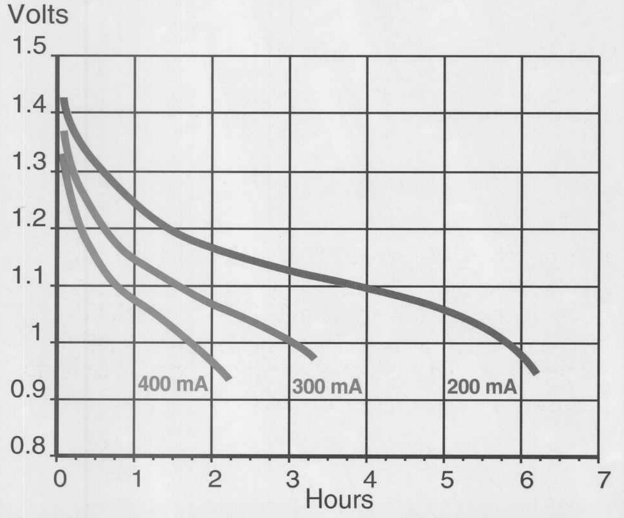
The run-time from a fresh set of batteries can be estimated by the initial capacity curves below. The run time obtainable from the same set of batteries after multiple charge and discharge cycles can be estimated from the cycle capacity curves or by multiplying the percentage of capacity fade as shown in the following section by the initial capacity value.

Constant Current Discharge Capacity

These figures show the voltage profile for constant current discharge at various rates of discharge. The curves show the capacity of a new cell on its first discharge.



AA Cell Initial Capacity—Low Current Discharge



AA Cell Initial Capacity—Moderate Current Discharge

The capacity of a cell for a specific operating condition (cutoff voltage and drain rate) is determined by multiplying the discharge rate by the time at which the voltage curve crosses the cutoff point used in the given application.

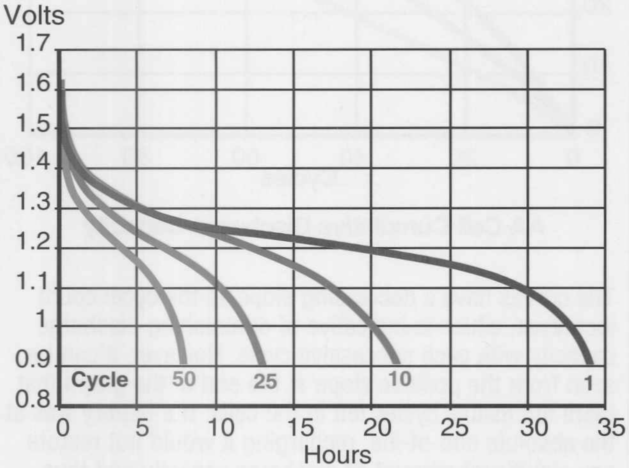
> *Example:*
>
> - *A portable device is powered by four AA-cells and has a minimum operating voltage of 4.0 volts. Cutoff voltage is therefore 1.0V/cell. Operating current is 100 mA.*
> - *On initial use the 100 mA discharge curve crosses 1 volt at approximately 16 hours.*
> - *Approximate initial capacity obtained from a Renewal AA cell:*
>
> *(100 mA) x (16 hours) = 1600 mA - Hr. (mAh)*

For comparison, a primary Alkaline AA cell would deliver around 2000 milliampere-hours and a typical consumer-grade NiCd would deliver 600 to 700 milliampere hours under these conditions.

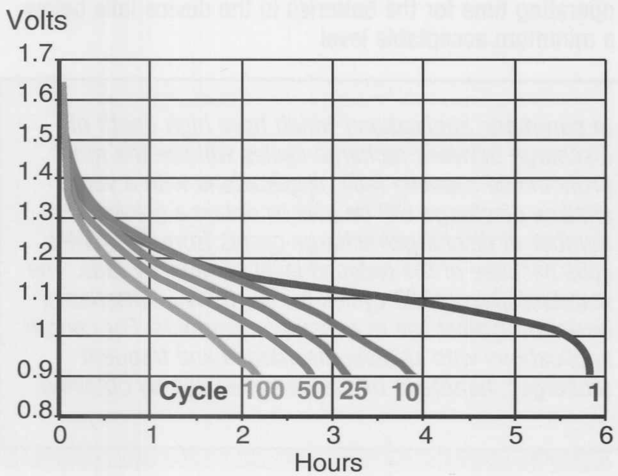
The graphs show that the milliampere-hour capacity available from the cell decreases with higher load rates. This is due to the voltage drop lost across the internal resistance of the cell, which becomes more significant at these higher rates

CELL CYCLE CAPACITIES

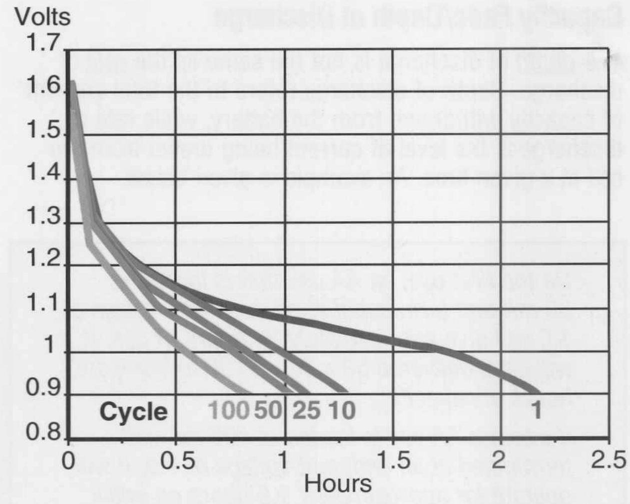
The following show the effect of charge/discharge cycles on the cell capacity at specific discharge rates. In each graph, the voltage profiles show the results obtained from the same cell for multiple discharges at the specified drain rate. Each discharge was terminated when the cell voltage dropped to 0.9 Volts.



AA Cell Cycle Capacities—50 mA Discharge



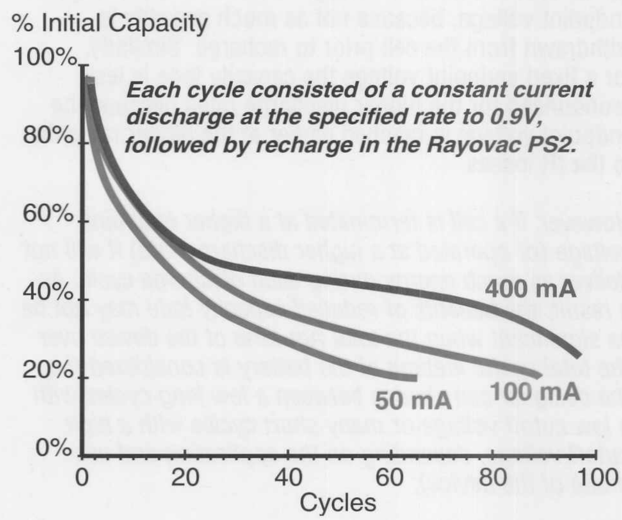
AA Cell Cycle Capacities—200 mA Discharge



AA Cell Cycle Capacities—400 mA Discharge

Cycle Life/Capacity Fade

On each successive discharge, the performance of the RENEWAL cell will be lower in comparison to the previous cycle. The next graph illustrates the loss in capacity as a function discharge cycle at different discharge rates. The batteries can continue to be charged and discharged if desired; the cell performance will continue to diminish accordingly.



AA Cell Capacity Fade

The degree of this deterioration will not be the same in all applications. It depends on factors such as rate of discharge and the endpoint voltage at which the discharge is terminated. These relate to the depth of discharge, or the amount of energy withdrawn from the battery prior to recharge for each cycle.

Capacity Fade/Depth of Discharge

The *depth* of discharge is not the same as the *rate* of discharge. Depth of discharge refers to the total amount of capacity withdrawn from the battery, while rate of discharge is the level of current being drawn from the cell at a given time. An example is given below.

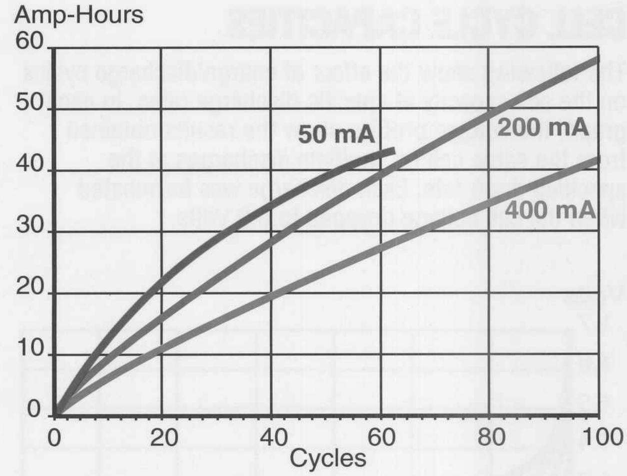
- *On the first use, an AA cell that is loaded at 50 mA and terminated at an endpoint voltage of 1.0 will give approximately 34 hours of use. It will have delivered 50 x 34 = 1700 milliampere-hours of capacity.*
- *If another AA cell is loaded at 400 mA and terminated at an endpoint voltage of 1.0, it will operate for approximately 1.6 hours on initial use. It will have delivered approximately 400 x 1.6 = 640 milliampere hours.*
- *Both cells were discharged to the same endpoint voltage. Even though the cell that was loaded at 400 mA had a much higher rate of discharge, it was subjected to a much lower depth of discharge.*

The degree of capacity fade at a specific discharge rate will be reduced if the discharge is terminated at a higher endpoint voltage, because not as much capacity is withdrawn from the cell prior to recharge. Similarly, for a fixed endpoint voltage the capacity fade is less pronounced for the higher discharge rates because the endpoint voltage is reached earlier at the higher rates due to the IR losses.

However, if a cell is terminated at a higher endpoint voltage (or operated at a higher discharge rate) it will not deliver as much energy during each discharge cycle. As a result, the benefits of reduced capacity fade may not be as significant when the total run-time of the device over the total useful lifetime of the battery is considered (i.e., the designer can choose between a few long cycles with a low cutoff voltage or many short cycles with a high cutoff voltage, depending on the application and use mode of the device).

AA Cell Cumulative Discharge Capacity

The following graph shows the cumulative capacity obtained over several cycles at specific discharge rates. Each discharge was terminated at a cell voltage of 0.9 volts. While the low rate discharge curves showed a higher degree of capacity fade than at high rates, it can be seen that the total capacity delivered is still higher when the cell is discharged at low drain rates to the same endpoint voltage.



AA Cell Cumulative Discharge Capacity

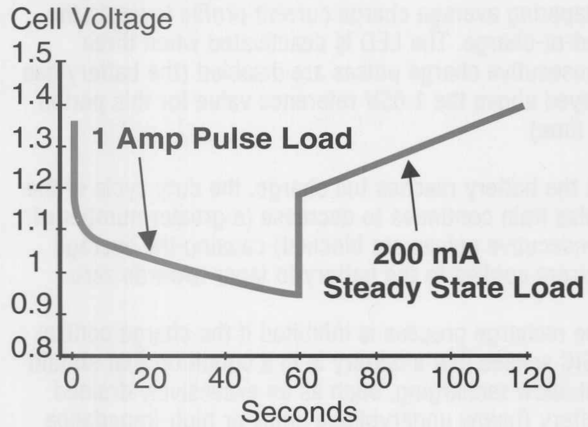
The curves have a decreasing slope as the cycle count increases, which is indicative of diminishing discharge capacity with each successive cycle. However, it can be seen from the positive slope at the end of the graph that there are usable cycles left in the cells. If a battery was at the absolute end-of-life, recharging it would not restore any significant amount of discharge capacity and thus the cumulative capacity would no longer increase with successive cycles. The number of usable cycles in a given application will depend on the point at which the operating time for the batteries in the device falls below a minimum acceptable level.

In summary, applications which have high depth of discharge between recharge cycles will see the most pronounced capacity fade. Applications with a very shallow discharge will be able to obtain a greater number of discharge/recharge cycles from RENEWAL cells because of the reduced level of capacity fade. The standard claim of 25 cycles for RENEWAL batteries is based on typical use in consumer products. For certain applications with shallow discharges and frequent recharges, hundreds of usable cycles can be obtained.

High-Current Pulse Response

The following graph illustrates the response of the RENEWAL AA cell when subjected to a 1 A pulsed load. The pulsed load was applied to a fully-charged cell for one minute. When the load level is reduced to 200 mA the cell voltage recovers to a normal operating level.

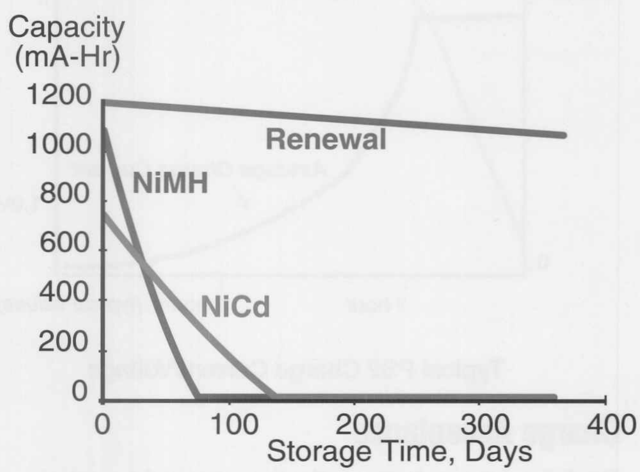
The cell was then discharged at a steady-state load condition of 200 mA until the voltage fell to 1.0 volt, representing an almost fully-discharged condition. The test was repeated over 25 full discharge cycles with similar results. Cycle 10 is illustrated as a typical response.



AA Cell Pulse Load Response

Self Discharge

RENEWAL batteries are similar to conventional primary alkaline batteries in their ability to retain their charge after periods of storage. Most other commercially available rechargeable battery systems exhibit a rapid self-discharge characteristic in which they are unable to remain charged when not in use. An approximate comparison is illustrated below.



Estimated Charge Retention in Storage

RENEWAL batteries retain their charge when not in use, so they do not require a "trickle charge" to keep them ready to use during storage.

Cell Impedance

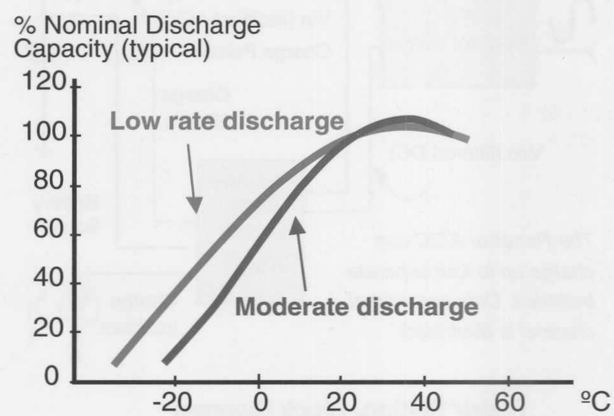
The standard method used to measure cell impedance consists of applying a low-level audio-frequency current signal to the cell and measuring the corresponding voltage change. The ratio of the measured voltage to the known input current is the cell impedance at the given signal frequency. This value provides a general indication of the rate capability of the cell relative to other cell types. Measured values for RENEWAL AA cells are typically 0.1Ω to 0.2Ω for fully charged cells.

The effective source impedance of a cell under closed-circuit operating conditions is, however, a function of several variables such as load level, state of charge, age of the cell, and operating frequency.

The parameter that is generally of most significance in an electronic system is the amount of sag (loss in terminal voltage) seen at the power source during a load transient. While this can be approximated based on the measured impedance of the battery, a more accurate estimate requires that a test similar to that shown in the previous illustration of pulse load response be performed at the load levels of interest for a particular application.

Temperature Performance

RENEWAL batteries provide best performance at moderate temperatures, generally between 0° and 50°C (32° to 122°F). An approximate indication of cell response at varying temperatures is illustrated here.



Approximate Effect of Temperature on Capacity

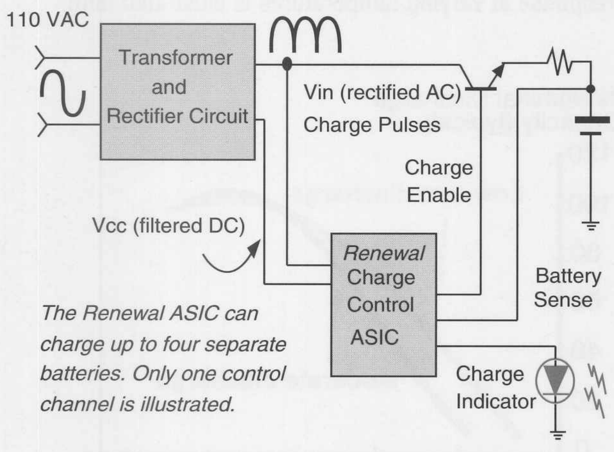
Chemical reaction rates are decreased at lower temperature. As a result, batteries will exhibit a loss in performance (particularly rate capability and high-rate capacity) at lower temperatures when compared to room-temperature performance. Similarly, at slightly elevated temperatures, a greater amount of capacity can be delivered by the cells. However, as the temperature increases beyond a certain level, internal pressure buildup caused by gas formation internal to the cell may cause cell failure.

RENEWAL® CHARGING METHOD

The RENEWAL Power Stations implement a special charge method as described below. The present chargers perform the recharge on each cell individually. The characteristics of the Reusable Alkaline system require that the charging of the cells be done on an individual cell basis and not on a series connection of cells.

Many of the standard techniques used with NiCd/NiMH fast chargers such as $-\Delta V/\Delta t$ slope detection, absolute temperature-cutoff, or $\Delta T/\Delta t$ termination are not compatible with Reusable Alkaline batteries. Continuous trickle charging and overcharging as used in many low-cost NiCd chargers is also not acceptable.

RENEWAL batteries are charged using a pulse charge method. Fixed amplitude, variable duty cycle pulses are applied to the battery during charge. The pulses are limited in amplitude by current-limiting resistors. The duty cycle is modulated by a control chip (Application Specific Integrated Circuit, or ASIC) specifically designed for use in the RENEWAL Power Stations. The average value of the charging current applied to the batteries is gradually reduced as the open-circuit voltage of the battery increases during the charge. The charging mechanism compensates for the internal resistance of the cell by taking the voltage measurement of the cell during the off-time of the charging pulse.



Power Station® Block Diagram

As illustrated above, the transformer in the charger has two outputs. The signal labeled "Vin" is a rectified (but not filtered) sine wave which provides 120Hz pulses at an amplitude of approximately 4 volts peak; the other (designated as Vcc) is a filtered output that provides approximately 8VDC to operate the ASIC and also provide a positive bias to turn on the NPN pass transistors. The voltage outputs are derived from an unregulated step-down transformer, so they will vary somewhat over line and load changes.

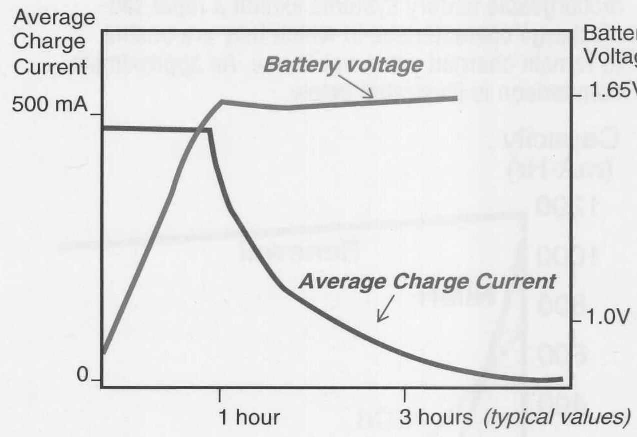
The Vin pulses are used for charging the battery. The ASIC monitors the battery voltage during the time when the pulse amplitude is low to get an accurate *open circuit voltage* (OCV) measurement. Monitoring the battery during charge (when the pulse amplitude is higher than the battery's OCV) will give a higher reading due to the battery's internal resistance.

As the ASIC senses the battery's OCV, it determines how much charge the battery receives by modulating the duty cycle of the base drive signal to the NPN pass transistor. As the OCV of the battery increases, the duty cycle of the DRIVE signal is reduced accordingly, resulting in a tapering average charge current profile towards the end-of-charge. The LED is deactivated when three consecutive charge pulses are disabled (the battery has stayed above the 1.65V reference value for this period of time).

As the battery reaches full charge, the duty cycle of the pulse train continues to decrease (a greater number of consecutive pulses are blocked) causing the average current applied to the battery to taper towards zero.

The recharge process is inhibited if the charge control ASIC senses that a battery is in a condition that should not allow recharging, such as an excessively drained battery (below undervoltage limit) or high-impedance battery (above overvoltage limit when charge current is applied).

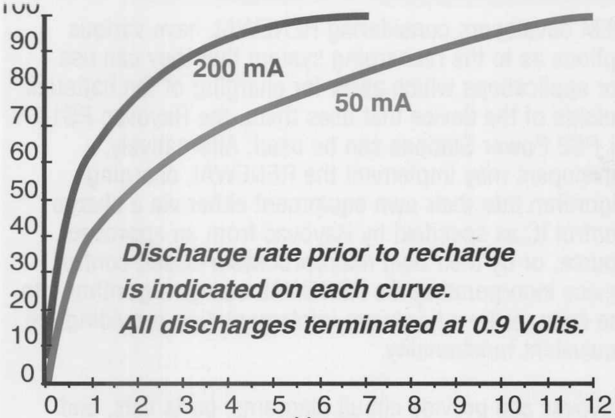
A typical cell voltage/current profile during the recharge process is shown below.



Typical PS2 Charge Current/Voltage

Charge Acceptance

The following graph shows the time required to restore the AA cell to a given state of charge after various discharge conditions. The cells were recharged in the PS2 Power Station after being discharged at different rates to the same endpoint voltage.



PS2 Charge Time for Different Discharge Conditions

battery as long as the discharge rate and endpoint voltage are kept consistent for each discharge. The data is shown for cycle 10 as a representative indication.

The illustration shows that if the same peak charge rate is used, the length of time required to reach full charge is higher for the lower-rate discharge case when the endpoint voltage of the discharge is the same. This is because the low-rate cell had a significantly greater depth of discharge (as described in the earlier section on cycle life and capacity fade). Since the cells were all recharged at the same rate, the cells which had been more fully drained required a longer time to be restored to a full state of charge.

For purposes of this illustration, "full charge" is defined as the point when the average charge current delivered to the cell had tapered to a negligibly low value (a few milliamps or less). This means that the amount of capacity being added to the battery by the charger was asymptotically approaching zero. The LED-out point for the Rayovac Power Stations™ generally corresponds to a state of 80 - 85% of this level, depending on the discharge condition of the cell.

SYSTEM DESIGN CONSIDERATIONS

The performance of RENEWAL batteries in a given electronic system can be optimized if the system contains circuitry to manage the use of the batteries.

Discharge Monitoring

The cycle life of the cells is optimized if they are not excessively discharged. A cutoff voltage of no less than 0.8V per cell is recommended. In particular, cell reversal should be avoided. If multiple cells are connected in series, some cells may be drained more rapidly than others due to mismatches in internal resistance or initial voltage between the cells.

In NiCd/NiMH based systems with cells connected in series, the total voltage of the series string is generally used to indicate a low battery or cutoff condition. In the case of RENEWAL, the low battery cutoff should occur when any one of the individual cells in the series connection reaches the low-voltage threshold. While this may reduce the operating time for a given discharge cycle (because the operation is effectively terminated when the weakest of all the cells is drained), it will avoid the overdischarge or reversal that may occur if only the overall voltage of the series connection is monitored.

The low-battery warning can be made by a voltage measurement only (it is generally not necessary to attempt to detect the "knee" of discharge by monitoring dV/dt as is often done in NiCd/NiMH systems due to their flat discharge curve). If a prediction of residual capacity is required at a certain voltage point, the circuit should be calibrated for the current level at which the device is operating as the in-circuit voltage of the batteries will depend on the load current. The threshold for cutoff can be set to a level appropriate for the application based on run-time, load rate, and cycle life requirements.

Pulse/Transient Loads

As is observable from the discharge curves, a cell loaded at 200 mA will last more than twice as long as a cell loaded at 400 mA. Thus, a constant 200 mA load will last longer than a 400 mA load at 50% pulsed duty cycle (even though both load conditions have the same average value).

Switch-mode power supplies used for DC/DC conversion in portable products will often place discontinuous loads or current spikes on the power source. Input bypass capacitors of sufficient value to supply energy to the converter during these transients will reduce the pulsed load placed directly on the cell, which can increase the product's run time.

Charging System Implementation

OEM developers considering RENEWAL have various options as to the recharging system that they can use. For applications which allow for charging of the batteries outside of the device that uses them, the Rayovac PS1 or PS2 Power Stations can be used. Alternatively, developers may implement the RENEWAL charging algorithm into their own equipment either via a charge-control IC as specified by Rayovac from an approved source, or by their own microprocessor-based control device incorporating the RENEWAL charge algorithm into the code, or by a hardware implementation providing the equivalent functionality.

Rayovac can provide circuit diagrams, parts lists, and sources for the unique components in the Rayovac Power Stations to OEMs who wish to incorporate the charging circuitry into their own products. Rayovac may request that OEM developers who wish to implement their own charging system agree to a contract of mutual non-disclosure prior to receiving this information.

Any circuitry associated with the charging of RENEWAL batteries should be reviewed and approved by Rayovac prior to product release.

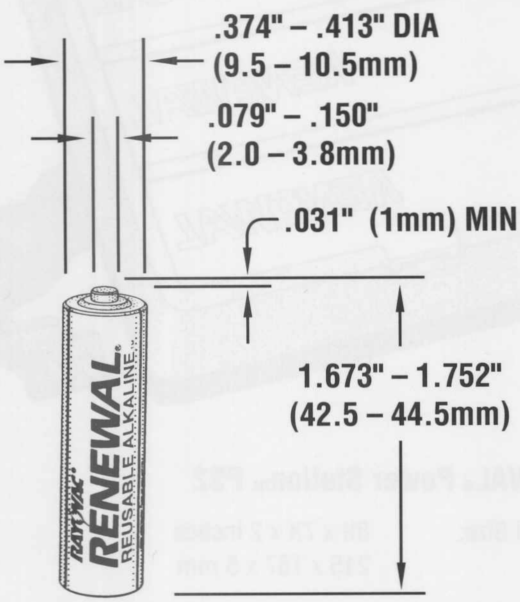
Storage and Replacement

The storage characteristics of RENEWAL are generally comparable to primary alkaline batteries. High temperature storage conditions will reduce the shelf life of the batteries and should therefore be avoided if possible. The RENEWAL cells will retain their capacity best if left in a fully charged state prior to storage.

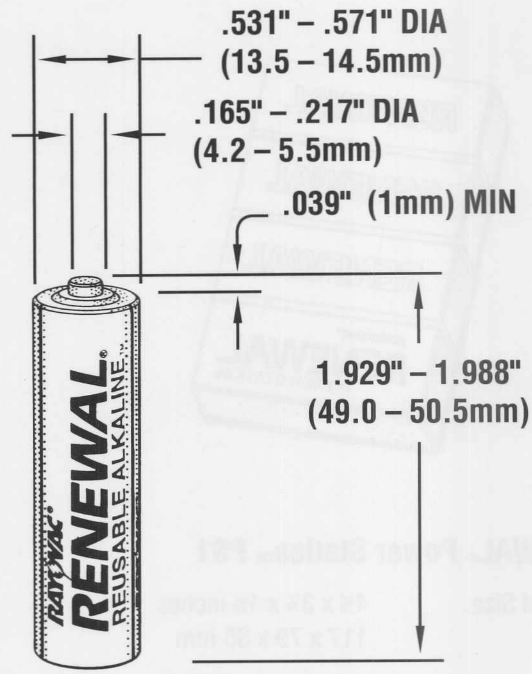
Circuitry connected to the batteries should not place a continuous load on the cells during periods of storage. This could possibly overdischarge them (this is referred to as a "loaded storage" condition that is considered undesirable for any rechargeable battery system). For example, a resistance placed across the battery terminals as part of a battery monitoring circuit should be disconnected when the device is not in use. Otherwise, it could eventually discharge the cells below the undervoltage limit of the charger. This will reduce the rechargeability of the cells.

As with any battery system, when cells are replaced at the end of their useful cycle life, all cells in the device should be replaced simultaneously.

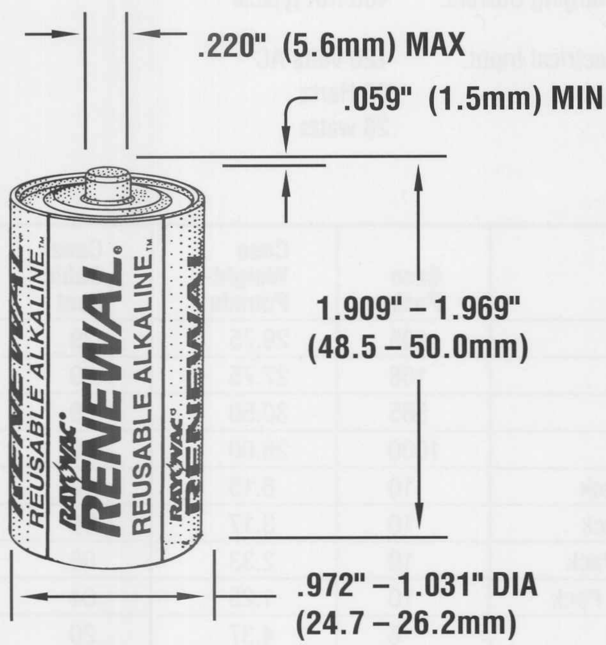
DIMENSIONAL SPECIFICATIONS



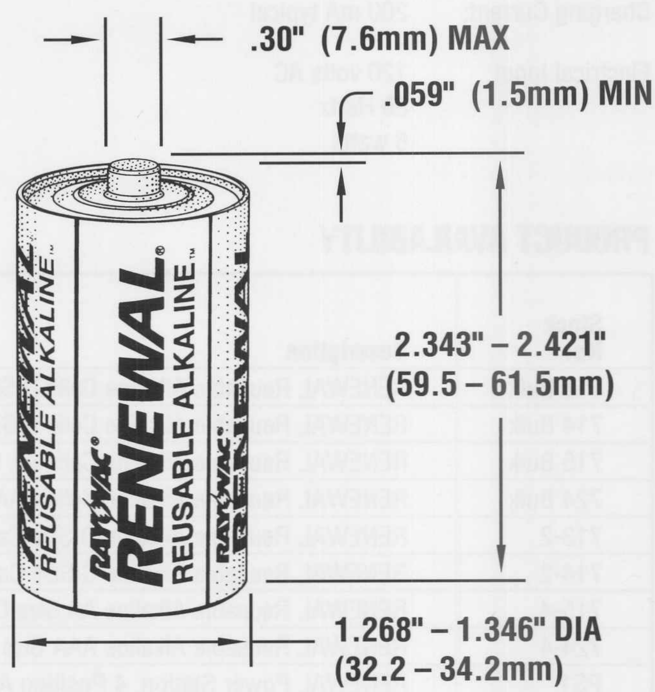
AAA Size RENEWAL® Battery



AA Size RENEWAL® Battery

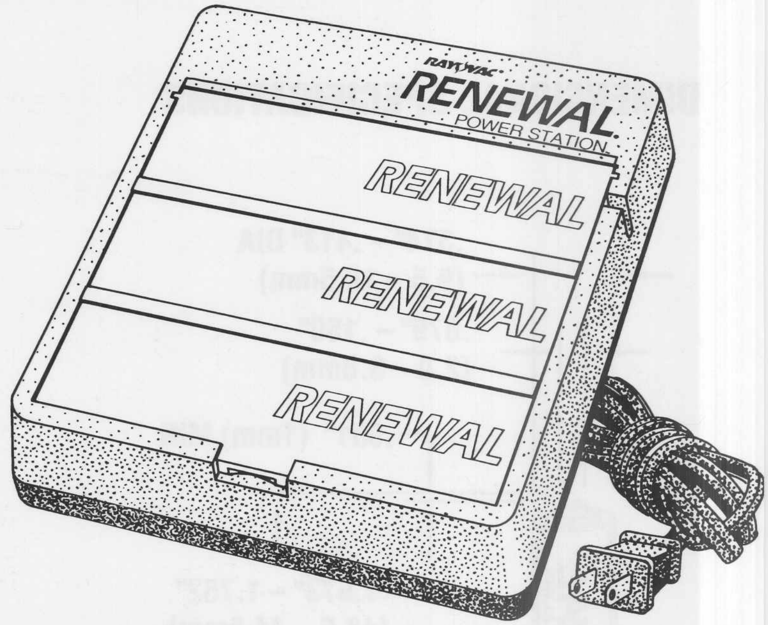


C Size RENEWAL® Battery



D Size RENEWAL® Battery

POWER STATIONS™



RENEWAL® Power Station™ PS1

Physical Size: 4⅝ x 3⅛ x 1⅜ inches
117 x 79 x 35 mm

Battery Sizes: AA and AAA RENEWAL batteries only

Battery Quantity: Any combination of one to four AA and AAA can be charged at one time.

LED Indicators: Indicate battery inserted and charging properly

Charging Current: 200 mA typical

Electrical Input: 120 volts AC
60 Hertz
6 watts

RENEWAL® Power Station™ PS2

Physical Size: 8½ x 7⅜ x 2 inches
215 x 187 x 5 mm

Battery Sizes: D, C, AA and AAA RENEWAL batteries only

Battery Quantity: Any combination of one to eight AA, AAA, D and C can be charged at one time.

LED Indicators: Indicate battery inserted and charging properly

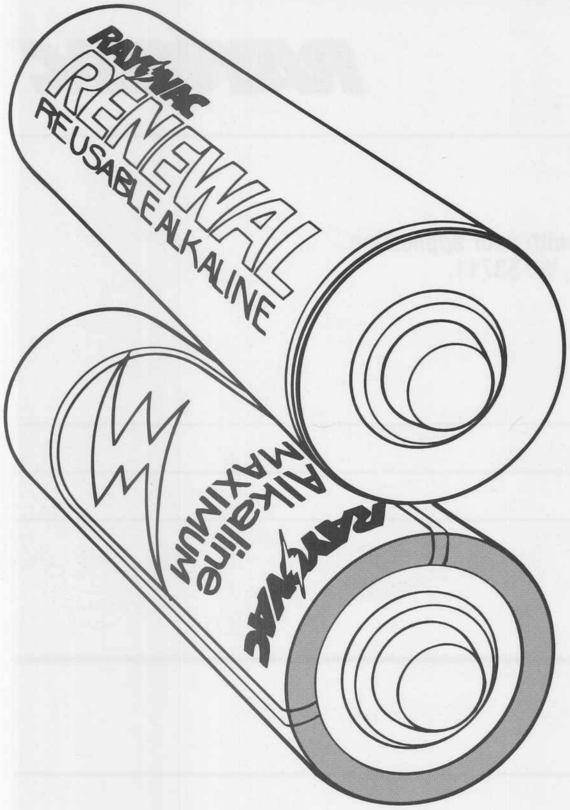
Charging Current: 400 mA typical

Electrical Input: 120 volts AC
60 Hertz
28 watts

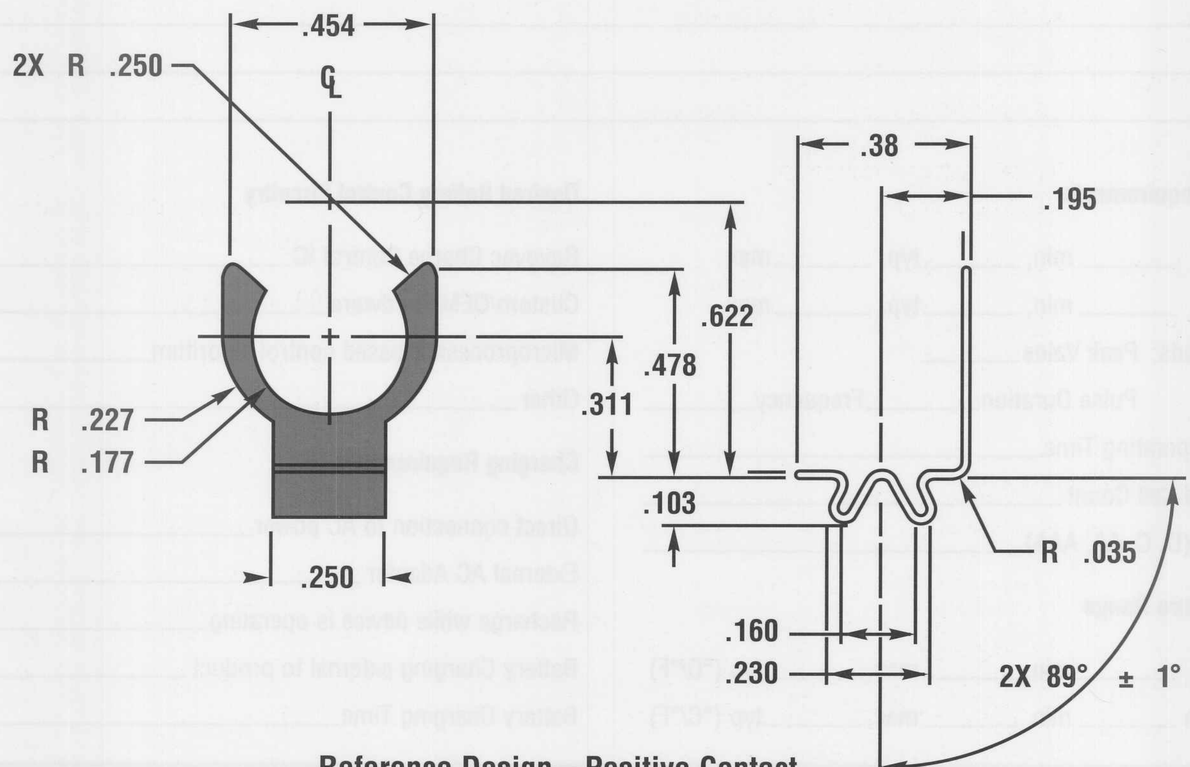
PRODUCT AVAILABILITY

Stock No.	Description	Case Pack	Case Weight-Pounds	Case Cubic Feet
713 Bulk	RENEWAL Reusable Alkaline Cells D Size	105	29.75	.29
714 Bulk	RENEWAL Reusable Alkaline Cells C Size	168	27.75	.29
715 Bulk	RENEWAL Reusable Alkaline Cells AA Size	585	30.50	.29
724 Bulk	RENEWAL Reusable Alkaline Cells AAA Size	1000	26.00	.30
713-2	RENEWAL Reusable Alkaline D Size Carded 2 Pack	10	6.15	.12
714-2	RENEWAL Reusable Alkaline C Size Carded 2 Pack	10	3.17	.09
715-4	RENEWAL Reusable Alkaline AA Size Carded 4 Pack	10	2.33	.06
724-4	RENEWAL Reusable Alkaline AAA Size Carded 4 Pack	10	1.25	.04
PS1	RENEWAL Power Station, 4 Position AA/AAA	6	4.37	.20
PS2	RENEWAL Power Station, 8 Position AA/AAA/C/D	4	9.50	.59

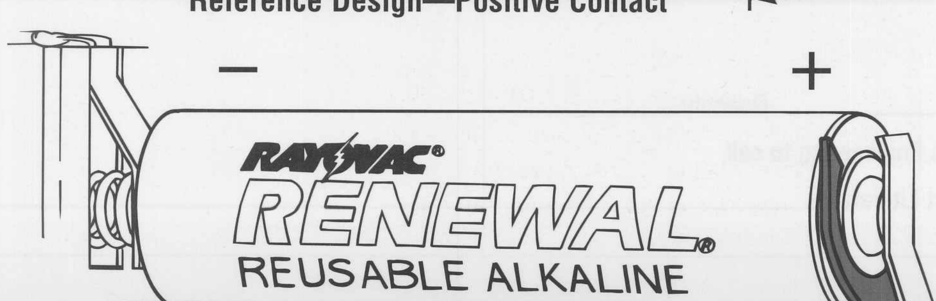
BATTERY CHARGING TERMINAL CONTACTS



- RENEWAL® AA and AAA cells have an exposed metal surface on the top of the cell case.
- Conventional alkaline cells have an insulating layer covering this surface.
- A special contact mechanism allows a product to operate from either type of battery, but charge only RENEWAL cells.



Reference Design—Positive Contact



RAYOVAC®

RENEWAL® APPLICATIONS ENGINEERING WORKSHEET

Mail or fax to the Rayovac OEM Sales Department for technical assistance with your application.
Telephone 608-275-4702, Fax 608-275-4994, 601 Rayovac Drive, Madison, WI 53711.

Customer Information

Name______________________ Title______________________

Company______________________ Phone______________________

Address______________________ Fax______________________

____

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Application Description

____

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____

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Battery Requirements

Voltage: ______ min, ______ typ, ______ max

Current: ______ min, ______ typ, ______ max

Pulse Loads: Peak Value______

Pulse Duration______ Frequency______

Battery Operating Time______________________

Estimated Cell Count______________________

Cell Size (D, C, AA, AAA)______________________

Temperature Range

Storage ______ min, ______ max, ______ typ (°C/°F)

Operation ______ min, ______ max, ______ typ (°C/°F)

Desired Battery Control Circuitry

Rayovac Charge Control IC______________________

Custom/OEM Hardware______________________

Microprocessor-based control algorithm______________________

Other______________________

Charging Requirements

Direct connection to AC power______________________

External AC Adapter______________________

Recharge while device is operating______________________

Battery Charging external to product______________________

Battery Charging Time______________________

Action Needed

❒ Samples: Type______ Quantity______

❒ Sales/Applications Engineering to call

❒ Additional Product Literature______________________

❒ Other______________________

Notice

This publication is furnished only as a guide. It is the user's responsibility to determine the suitability of the products described for the user's purpose (even if the use is described herein) and to take precautions for protection against any hazards attendant to the handling and use of the products.

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The technical data contained herein are not intended to be the basis for specifications. Rayovac's Quality Assurance Department can furnish data that can serve as the basis for specifications.

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